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Assessment of Solid Waste Disposal Practices in Rural Communities in Alaska

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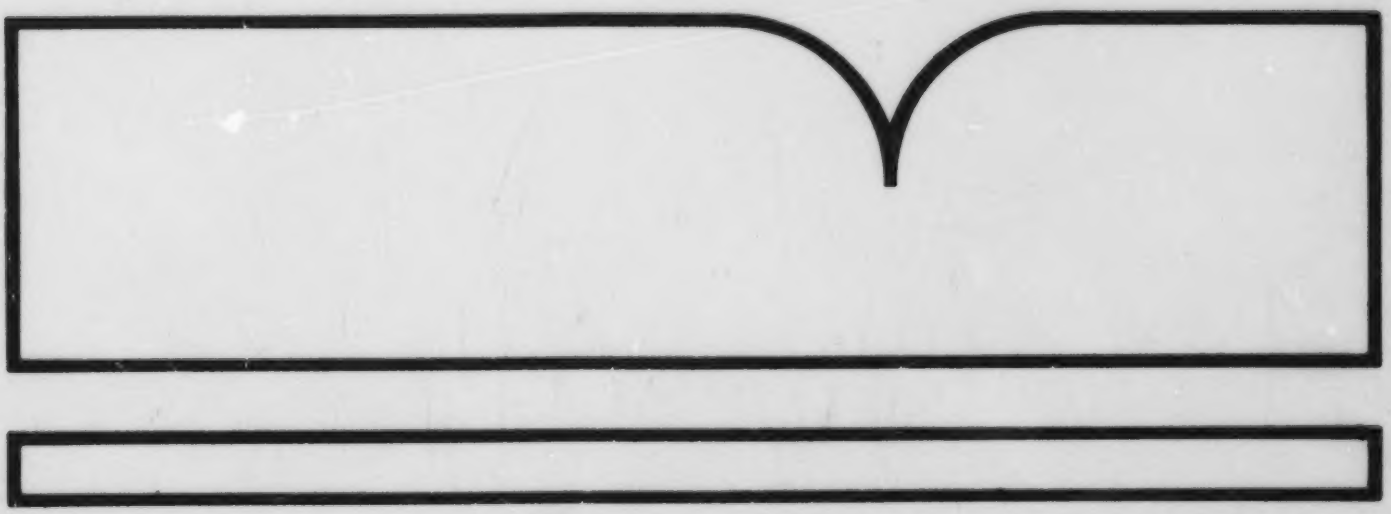

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AN ASSESSMENT OF SOLID WASTE DISPOSAL PRACTICES IN RURAL COMMUNITIES IN ALASKA

by

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A study was conducted of solid waste management practices in remote communities of Alaska during 1980-1982. This study was conducted in cooperation with the Alaska Department of Environmental Conservation. Solid waste management problems were identified for small communities in cold regions and analyses were conducted to determine viable alternatives, including open dumps, modified landfills and incineration. A very limited sampling program was conducted to determine solid waste characteristics. National and international literature was reviewed, including that of Canada. The project included site visits to several small villages, consultation with regulatory officials and discussion with several Canadian agencies and communities. A national survey was conducted relative to state regulations pertaining to small community practices.

The results of the study identified many problems existing in small communities in cold climates and found that in many cases state regulations are not enforced and may not be appropriate. The study includes an analysis of solutions and alternatives available.

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CHAPTER 1

INTRODUCTION

Environmental engineering in Alaska often requires unique and/or modified design concepts because of the severe climatological conditions and other limiting factors and constraints. Solid waste management is but one facet of cold climate engineering requiring specialized considerations.

Small communities (less than 500 population) have a difficult time operating and maintaining acceptable disposal processes. They are generally hampered by a limited economic base (no money), lack of a centralized refuse collection system (no equipment), an unskilled and untrained solid waste labor force (lack of specific training/education), and ineffective regulations for remote settings (little enforcement). Resultantly, many small communities operate open burning, poorly managed, and unacceptable open dumps. This report focuses on the problems of solid waste management in small communities of Alaska. A brief review of the literature is included as well as problem identification and an exploration of alternative solutions.

Solid Waste Management

Solid waste management usually refers to the collection, disposal and general management of solid waste (refuse). The refuse is discarded solid material which has lost its immediate economic value to the user and thus has become a waste item. It has been commonly reported that approximately 80% of the cost for solid waste management is assessed to the collection process and only 20% to the disposal process. These percentages are not specific to small communities but rather are indicative of costs generally. Numerous problems invariably occur with the disposal alternatives, however.

Components of solid waste (refuse) are widely varied. It is estimated that the average production rate (generation rate) for the U.S. is about 3.63 kg (8 lb) per person per day (Tchobanoglous et al., 1977). This value, however, includes residential, commercial, and industrial components of refuse.

Solid waste disposal alternatives include landfilling, incineration and processing (baling, shredding, composting, recycling and others). Some of these options will be discussed in detail in this report.

The objectives of solid waste management include the safe and efficient disposal of waste so as to avoid or reduce hazards, nuisances and aesthetic blights. Some 22 diseases have been isolated from solid waste where human feces were present (Hanks, 1967).

National, state and local regulations significantly restrict disposal operations to insure healthful and efficient management. These regulations, however, are often ineffective or ignored in small communities in remote settings. Small communities across the U.S. and Canada have traditionally followed a pattern of open dumping -- a process which has little or no management and is generally considered unacceptable.

CHAPTER 2

CONCLUSIONS

1. A large number of open dumps exist in Alaska. It is most probable that these landfill operations are in violation of RCRA criteria.

2. Solid waste generation rates in remote communities range from 1.34 to 8.0 pounds (0.61 to 3.63 kilograms) per capita per day. Suggested design values for small rural communities are 2 to 4 pounds (0.91 to 1.81 kilograms) per capita per day, and the density of the uncompacted refuse is expected to range from 125 to 250 pounds per cubic yard.

3. Very little is known about the characteristics (quantity and quality) of solid waste in small remote locations. Furthermore, there is virtually no information in the literature on experience of land disposal in permafrost. Although there are numerous dumps located in permafrost, no documentation exists as to the consequences of such practice. Where possible, permafrost should be avoided. These two areas need extensive research.

4. It is essential that indiscriminate open dumping of solid waste and human sewage be stopped and replaced by controlled, supervised, and approved methods of disposal.

5. In general, advanced processing of solid waste in small communities is cost prohibitive. Modified landfilling seems to be the most economical of alternatives available.

6. State and local regulations are not specific for small community solid waste disposal operations. These should be changed to reflect reality where possible and where politically feasible -- not only in Alaska but nationally.

7. Open burning of waste should be considered a viable alternative -- with reservations. This should be done only on a permit basis, specifying proper meteorological conditions, restrictions and other considerations.

8. Small community government officials are in general not educated to proper solid waste disposal methods and thus properly designated educational materials are needed to correct this deficiency.

9. Use of the "burn box" incinerator should be further evaluated. This unit looks particularly promising for small rural communities for volume

reduction and control of nuisance conditions.

10. Simplicity of design must be maintained because of the small economy of scale. Resources in small remote communities are extremely limited, and high capital and operational cost technologies will not be acceptable.

CHAPTER 3

COLD CLIMATE SOLID WASTE PROBLEMS

There are many unique conditions in Alaska resulting in complex, specialized solid waste management problems. These include such factors as a widely dispersed population, severe climatological conditions, permafrost, land litigation problems, a lack of an economic base for many small communities, a severely restricted transportation system and others. These factors and how they affect solid waste management in Alaska are discussed in the following paragraphs.

Alaskan Population

Alaska is a very large state encompassing some $1.52(10^6)$ square kilometers (386,400 square miles). The state, however, has a relatively small population of 400,481 which is widely dispersed (U.S. Department of Commerce, 1981). Of the total population, 309,922 live within incorporated city limits comprising 143 communities. Of these communities, 103 had populations less than 500, 18 had populations between 500 and 1000, 17 were between 1000 and 5000, and only five had populations greater than 5000. Better than half of the state population are to be found in three communities -- Anchorage (173,017), Fairbanks (22,645), and Juneau (19,528).

The importance of population density to effective/efficient solid waste management should be evident. Wide dispersement of this population across the state -- and in particular when coupled with a "skeleton" transportation system -- results in the reduction of viable alternatives available for solid waste disposal. This problem is not limited to Alaska as similar distributions and occurrences exist in Canada's Yukon and Northwest Territories (Smith, 1980). These areas, including Alaska, are typified by settlements or clusters of people commonly having populations less than 500. Although the 1980 census for Alaska reported 103 incorporated communities having populations of less than 500, it is estimated that there are more than 200 "clusters" (including incorporated and unincorporated groups) having populations less than 500. About half of these clusters have populations of less than 100 people (Alaska Department of Environmental Conservation, 1977; Smith, 1980; and Lynch, 1981). The significance of these distributions and low population densities becomes very important when considering "economy of scale."

Alaskan Climate

The state has a broad range of climatic conditions transecting three climatic zones: temperate in southeastern Alaska, subarctic in interior Alaska

and arctic in northern and western Alaska. Mean annual precipitation ranges from 10 to 510 centimeters (4 to 300 inches), mean annual snowfall ranges from 50 to 570 centimeters (20 to 225 inches), mean annual temperatures range from less than -12°C (10°F) to greater than +7°C (45°F) and temperature extremes range from -60°C (-75°F) to +38°C (+100°F). In addition to these severe climatic conditions which can seriously impact engineering designs, Alaska has a unique soil condition known as permafrost. Permafrost, or permanently frozen ground, is found throughout Alaska and may be continuous or discontinuous (Hartman and Johnson, 1978).

The severe climatological conditions mentioned previously can seriously affect modes of operation for solid waste disposal systems. Low temperatures impede biodegradation as well as restrict the latitude of operational concerns. Excessive precipitation can result in solid waste leachate, and it can also limit or reduce the number of acceptable disposal sites. Frozen ground obviously is expensive to excavate. If not properly managed, it can subsequently produce a water quality problem in addition to erosion control problems. In general, design in permafrost (structures, foundations, highways, pipelines, etc.) is generally approached by (1) avoiding it, (2) destroying it, or (3) preserving it.

Solid Waste Management in Alaskan Communities

Solid waste disposal in Alaska has been typified by landfilling and open dumping. Unhealthy and unsightly open dumps exist in most small (arbitrarily less than 500) villages of Alaska where 76% of the communities use open dumps, 11% use modified landfills, and the remaining 13% use ocean or river disposal. A small fraction of the communities utilize incineration, but all incinerator operations are federal facilities (Alaska Department of Environmental Conservation, 1977). A statewide survey initiated by ADEC in 1977 (Alaska Department of Environmental Conservation, 1977) found that open burning was practiced at 22% of the communities and that only 12% had any form of centralized collection system. Bears were noted as problems at several sites and, in general, littering was widespread. Several of the landfills were designed and operated by the United States Public Health Service and the Alaska Department of Transportation and Public Facilities.

A summary detailing solid waste disposal conditions for Alaskan villages is included in Appendix A. It is included with this report to provide basic information for some 206 Alaskan community solid waste operations. The descriptions also provide documentation of the conditions prevalent and a bleak view of the solid waste management conditions therein. Of the villages included in the survey, 70 had populations less than 100, 180 had populations less than 500, 200 had populations less than 1000, and six had populations greater than 1000. A very large percentage of these sites were categorized as open dumps, and a large fraction were located in continuous/discontinuous permafrost.

In 1981 the Northern Region of the Alaska Department of Environmental Conservation inspected 25 remote solid waste dumps (Ward, 1982). Numerous problems were identified including dead animal remains, honeybucket wastes and possible contacts with potable water supplies. Additionally, several sites

were inhabited by fox which were suspect of rabies. Another major problem was that many villages did not have centralized disposal sites, but rather had indiscriminate dumping throughout and around the village proper.

Most of the disposal facilities violate the RCRA criteria established for sanitary landfills for a variety of reasons, and thus are in violation of state and federal laws. The attendant problems include open burning, littering, discharge into waterbodies, nuisance factors and no vector control.

Factors contributing to solid waste problems in cold climates have been identified by Alter (1969) and include: 1) lack of responsibility for proper management of solid wastes; 2) nomadic, explorative and transient attitudes toward occupation of cold regions; 3) the human tendency during severe weather to escape from elements by spending as little time as possible outside; 4) unfamiliarity with the forces, resources, and regimen of the cold regions environment; 5) lack of transportation; 6) shortage of trained personnel; 7) relatively high cost of cold regions operations; and 8) insufficient information on generation and characteristics of cold region solid wastes.

Small community waste disposal problems are further complicated by social, cultural and economic factors. Past efforts have involved the transfer of technology from developed areas of warmer climates. Many of these efforts failed because people were fitted to solutions rather than solutions to people, and because economic conditions did not warrant such processes (Environment Canada, 1975; and Reid, 1980).

Solid Waste Characteristics

Although solid waste constituents are largely the same regardless of location, this is not totally true in Alaska. A major portion of solid waste is generated outside of Alaska and transported to the state where it is disposed. An unusually large portion of solid waste may be paper and other packaging materials used to ship items into the state.

Information as to the amount of solid waste generated in small remote localities is very limited. It appears a common design value used is about 2.27 kilograms (5 pounds) to 3.63 kilograms (8.0 pounds) per capita per day (Alter, 1969; Smith and Straughn, 1971; Associated Engineering Services, Ltd., 1973; Alberta Environment, 1981a; Alberta Environment 1981b; and Cormie, 1982). More recent information suggests that the lower value of the generation rates is applicable to small remote communities -- i.e., near 2.0 pounds per capita per day. The United States Public Health Service used design rates of 2.5 to 3.0 pounds (1.13 to 1.36 kilograms) per capita per day for facilities at Nenana, Alaska (U.S.P.H.S., 1980a). Other studies from Alberta, Canada, found an average of 3.3 pounds (1.50 kilograms) per capita per day for residential refuse from eight communities (Alberta Environment, 1978; and U.S.E.P.A., 1979). Additional Alberta investigations found urban refuse to be about 1.84 pounds (0.84 kilograms) per capita per day for some 12 cities, 1.34 pounds (0.61 kilograms) per capita per day in three different surveys, and an uncompacted refuse density of 150 pounds per cubic yard (Alberta Environment, 1978; and Bissell and Associates, undated).

It is apparent from these studies that the past practice of using common design rates ranging from 5 to 8 pounds per capita per day will lead to overdesign. For remote rural settings, a generation rate of 2 to 4 pounds per capita per day seems reasonable.

Solid Waste Measurements

As a part of this project, limited attempts were undertaken to measure and quantify wastes in selected Alaskan villages. It was not the intent of this study to conduct a detailed research project on this subject. However, due to finite resources, insufficient information was obtained, and the results were deemed not statistically reliable. Therefore, they are not included here. Site visits and measurements were taken at Nenana (4), Anderson (1), McKinley Village (1), Tanacross (3), Eagle City (1) and Kotzebue (2). Where and when possible, these site visits were conducted with personnel of the Alaska Department of Environmental Conservation. Measurements were taken weighing refuse on a 60-pound Pelouze spring scale hung from a tripod. The scale weighed to the nearest 0.2 pound and was calibrated for accuracy against a standard.

The importance of the information gathered is significant to future needs even though the actual numbers are not presented here. On several occasions, no waste was deposited at the solid waste disposal sites during a 24-hour sampling period. On another occasion, several thousand pounds of scrap steel were disposed. These extreme variations, when coupled with the few samples yielded very inconclusive information. A major conclusion of this study was the determination that detailed research is needed regarding the characteristics and amounts of solid waste disposed in remote small communities, and this research will be a very expensive undertaking. The lack of specific information (composition, density, per capita generation, seasonal variability, etc.), which has been obtained through actual measurements rather than estimates, will hamper the design and operation of solid waste facilities. It can be argued that the expense necessary to obtain this information may not be justified through improved design or management of new systems. Nonetheless, the lack of accurate information will continue to serve as supposed justification to continue operation of facilities that are inadequate and without management; i.e., open dumps.

Until such time that descriptive solid waste information is obtained, it is recommended that generation rates of 2 to 4 pounds per capita per day be anticipated. It is further recommended that consultants and/or design agencies be cognizant of variability in waste characteristics, as well as seasonal changes, such as extra packaging materials, "honeybucket" waste, animal and fish carcasses, and others. The State of Alaska (ADEC) should take steps to gather required information as soon as practicable to ensure that solid waste management practices meet minimum standards to provide health protection to community residents, and to provide environmental protection including esthetic values and freedom from pollution. These efforts can be jointly addressed through combined studies of government, private practice and the University.

CHAPTER 4

SOLID WASTE REGULATIONS

Solid waste regulations were first formally adopted in the United States in 1965. Public Law 89-272, known as the Solid Waste Disposal Act, was the first step by the federal government to control solid waste on a national level. The Resource Conservation and Recovery Act (RCRA) was passed by Congress in 1976 (P.L. 94-580 of 1976). This legislation was much more extensive than previous efforts and is discussed in detail in the following paragraphs.

Resource Conservation and Recovery Act of 1976

The Resource Conservation and Recovery Act (RCRA) had a primary objective of establishing a cooperative relationship in solid waste management among federal, state and local governments. Other objectives included the classification and closing of open dumps, regulation of hazardous wastes and the promotion of resource recovery of valuable materials and energy from solid waste.

As a result of RCRA, the U.S. Environmental Protection Agency issued "Criteria for Classification of Solid Waste Disposal Facilities and Practices" in 1979 (U.S.E.P.A., 1980). These criteria established minimum national standards for the protection of health and the environment from adverse effects resulting from solid waste disposal. Additionally, a facilities evaluation procedure was established so each state would evaluate existing solid waste disposal facilities in conjunction with the established criteria. These criteria included standards for the eight major categories of air (pollution), safety (explosive fires, bird hazards to aircraft, and access), surface water (contamination), groundwater (contamination), endangered species, disease (vectors, and sewage sludge and septic tank pumpings), application to land used for the production of food chain crops, and floodplains (innundation). Failure to meet these criteria can result in the classification and listing in the EPA Open Dump Inventory. This classification/inventory provides few incentives to the affected states and communities for corrective action. Thus it is questionable as to the effectiveness of the procedure.

EPA open dump inventory reports were completed for sites visited for this study. Although they are not included in this project report, in the strictest sense none of the facilities would pass inspection. For that matter, it is doubtful if any landfill in Alaska could fulfill the RCRA criteria. This is due to one or more violations of RCRA criteria including air pollution, safety (explosive gases, fires, bird hazards and access), water pollution (surface and

ground), endangered and threatened species, disease (vectors, sewage sludge and septage), application to land used for food chain crops, and/or location in floodplains (U.S.E.P.A., 1980; and Ward, 1982).

Alaskan Regulations

The State of Alaska adopted solid waste regulations in July 1974 (revised in October 1978) which are administered by the Alaska Department of Environmental Conservation (ADEC, Register 50, July, 1974, Title 18, Environmental Conservation Solid Waste Management, State of Alaska). Some significant parts of these regulations are: 1) incineration shall be considered as a viable processing alternative in the detailed plan required; 2) the disposal of putrescible waste in areas subject to permafrost or leachate generation is restricted and shall be allowed only in conjunction with special procedures approved by the department; 3) open burning on a landfill is prohibited; and 4) solid waste shall be deposited in a manner to prevent waste materials, leachate or eroded soil particles from entering the waters of the state.

The State of Alaska is actively involved with the RCRA open dump inventory, as well as providing technical assistance to small communities (Alaska Department of Environmental Conservation, 1977). Recently the State of Alaska has been providing financial assistance to small communities in the form of grants for improved solid waste management systems (Ward, 1982). Furthermore, the Alaska Department of Environmental Conservation is actively involved in the encouragement and promotion of resource recovery and conservation projects. A commendable effort is being exerted by ADEC in spite of a pronounced lack of manpower for enforcement and assistance.

National Survey of State Regulations

In an attempt to determine regulatory and management techniques presently applied in small communities, a national survey was conducted by contacting each of the 50 states (Steen, 1981). Major findings of this study included:

1. Solid waste regulations that specifically cover small communities (less than 5,000 people) are prevalent in states which are relatively sparsely populated. Densely populated states, in general, do not have regulations specifically for small communities.

2. Considerable flexibility is allowed among states in bringing solid waste disposal facilities in small communities into compliance with state regulations. This flexibility takes the form of (allowing) a lack of leachate control and daily cover, and also by allowing open burning. These variances allowed in state regulations result in many disposal facilities which are (would be) classified as open dumps under RCRA criteria.

3. While sanitary landfills are the main thrust of regulations for disposal sites in most states, modified landfills are still a widespread operational reality.

4. Pooling of resources for management of solid waste is becoming a significant tool in rural areas to replace open dumps with sanitary landfills which can accommodate waste from several communities, or even from an entire county.

5. Resource recovery appears to be insignificant, particularly for small communities, but is slowly gaining momentum as a way to reduce the amount of waste which ultimately must be disposed on the land.

6. Although not totally documented or identified, it is apparent that many states are not enforcing existing regulations. They admit, in many cases, to the impracticality of the current regulations for small communities. But rather than change them, they have opted to "turn the other cheek" so to speak.

Based on the results of this survey, it is clear that the problems of solid waste disposal and management in small communities are not limited to Alaska and northern Canada. It is also apparent that sparsely populated areas require special consideration, regulation, assistance, and designs for solid waste disposal. Table B-1 in Appendix B contains the results of the questionnaire submitted to the states.

CHAPTER 5

SMALL COMMUNITY WASTE DISPOSAL

Based on the literature reviewed and the results of this study, it is apparent that alternative disposal processes which are viable to small communities are limited primarily to land disposal and its modifications. Although some limited applications exist for incineration and other processing techniques, they are considered virtually unviable for a number of reasons which will be discussed later. As mentioned previously, limited state financial subsidies are available to assist small communities in Alaska.

Small communities are faced with many problems which contribute to and interact with the task of solid waste management. Communities with less than 500 people have a very limited economic base on which to draw for needed resources. These factors, when coupled with other considerations, make proper waste disposal a formidable undertaking. For example, the person(s) responsible for solid waste management in a small community may not be employed full-time by the community, he (she) may have numerous administrative assignments, including solid waste management, city clerk, public works, treasurer, dog catcher and others. The lack of formal training and education is also a deterrent to the use of more advanced processes.

On a prioritized basis, it seems the most important aspect to small community solid waste disposal is the elimination of indiscriminate dumping within the villages. This practice should be replaced by centralized collection and disposal processes even to the extent that a modified controlled open dump is better than uncontrolled dumping throughout a community. Additionally, river disposal and ocean (ice pack) disposal should be stopped and replaced by controlled land disposal techniques. Immediate action is needed to remove and process human wastes (honeybuckets) away from inhabited areas for reasons of health, sanitation and safety.

Literature on cold climate solid waste management is very limited. It is apparent that Canadian information is more extensive than that in the United States -- more information is probably available than that obtained for this report. A survey of Canadian communities and practices would be beneficial.

Incineration

Incineration is not well suited to small community needs because of its high capital, maintenance, and operational costs. Additionally, a high degree of skilled labor is required for proper processing of the waste. In many cases auxiliary fuel is required to initiate and maintain combustion (Smith and

Straughn, 1971; Associated Engineering Services, Ltd., 1973; and Reid, 1980). Because of the small amounts of refuse involved, most incinerators must be batch operated. This is inefficient because of start-up time and temperature fluctuations. Short-term storage of refuse (perhaps several days) for subsequent incineration has some merit but can result in other negative considerations such as vectors and nuisance conditions. Because of cyclic batch operations, it is doubtful that many small-scale incinerators could meet existing air pollution criteria. Additionally, incineration must be considered jointly with landfilling because of noncombustible and incinerator residue.

A study conducted by Giles (1981) was directed primarily at the use of incinerators in small communities. Results of the study indicated that controlled air incinerators and multiple chamber incinerators were cost prohibitive for populations of less than 5,000. Single chamber incinerators (silo/tepee) for a community of less than 750 were estimated to cost between $7,500 and $10,000 for capital expenditures, and were considered marginally prohibitive. Giles also concludes that open burning, under controlled conditions, should be considered for communities of less than 1,500 people and that single-chambered incinerators be evaluated for communities between 500 to 5,000 population and which are remote from human activities.

Recent research suggests that open pit incineration may have limited application for small remote communities at a relatively competitive price and with reasonable air pollution control (Environmental Protection Service, 1979; and Giles, 1981). Studies conducted by the State of Alaska during 1980 show some promise for a "burn box" for small community use. This is a "homemade" fabricated waste burner costing on the order of $2,500 that is capable of burning refuse from small communities on a daily basis. It is not known whether the "burn box" is capable of compliance with air pollution regulations. The process appears favorable and needs further evaluation (Ward, 1982).

Tests conducted by the Alaska Department of Environmental Conservation found that the 5-foot cube, 10-gauge sheet metal burn box could operate efficiently at a burn rate of 500 pounds per hour of unsegregated residential solid waste. Smoke opacity during this time averaged less than 10% with a volume reduction of 80% and a weight reduction of 60%. The box was capable of burning refuse from a community of about 150 persons. Some smoke and odor problems were evident during testing. The unit is not officially recommended by ADEC (Stokes, 1980).

Resource Recovery

Resource recovery in small communities, for the most part, is not practical. Nonetheless, several small communities have active resource recovery projects and these efforts should certainly not be discouraged. The success of small community efforts rests principally on individual initiatives and attitudes. Alaska's extreme geographical separation from the contiguous 48 states results in depressed market conditions. Extra charges for transportation of recovered goods hamper recycling efforts. The State of Alaska is currently active in promoting resource recovery projects by providing technical and financial assistance (Ward, 1982). This is a very positive step in proper waste management as well as in the education of the public. Some

recovery efforts are nothing more than long-term isolation cells in landfills where highly valued resources have been separated and buried (metals, glass, rubber, etc.). These storage efforts, nonetheless, are positive, productive steps in the total waste management cycle as recovery and utilization may occur at a later time when more favorable economic conditions will enhance recycling.

Solid Waste Processing

The general category of solid waste processing includes processes such as compaction, sorting, baling, shredding, composting and others. These processes are normally mechanical in makeup and relatively expensive. In most cases, processing is expressly for volume reduction and other process advantages. These processes require skilled labor, high levels of maintenance and in general cannot be economically justified for small communities (U.S.E.P.A., 1976).

Ocean Disposal

Remote coastal communities often store solid waste on the ice packs and subsequently depend on the vastness of the ocean for disposal of the waste materials. Although this disposal technique may have been tolerable in the past for small villages, it is no longer an acceptable process. Improved transportation systems, increased waste generation rates, and a better understanding of environmental degradation have made this past practice unacceptable.

Landfilling

Of all the solid waste disposal alternatives available to small communities, the only apparent viable process is a modified operation of a sanitary landfill. Other disposal processes are considered unacceptable for the most part because of economic limitations. Landfilling seems to provide the most advantages in terms of cost, land, operation and maintenance, and other factors. Should conditions warrant more advanced processing, and economic and other operational factors are favorable, communities should then explore options of incineration, regionalized collection and disposal, and others.

Even considering all of the more positive aspects to landfilling of refuse, there are many negative ones to overcome. These include the lack of suitable land, inadequate quality and quantity of cover material, permafrost conditions, unskilled and untrained labor for operation, minimal economic resources, lack of excavation/compacting equipment, and other factors.

Design. The design of modified landfills for small communities will require assistance from regulatory agencies. These designs could be standardized where possible and should be kept as simple in concept as regulations permit. This procedure is currently being used with a high degree of success in the Canadian Yukon (Cormie, 1982). Many criteria should be considered in the design process, some of which are discussed in the following sections of this report.

Land. Land requirements for small community solid waste disposal sites are minimal but can be a major factor in the total concept. Land requirements for a community of 100 would be approximately 0.3 acres for a 20-year design period. This calculation is based on the assumptions of 1.13 kilograms (4 pounds) per capita per day, and in-place density of 149 kilograms/cubic meter (250 lb/yd^3) and a liberal allowance of land for a buffer zone. Also, a trench-type operation would be utilized. Surface filling (not to include trenching) could reduce the amount of land required (due to almost unlimited height available) and in some cases surface filling might be the preferred method, as for example in permafrost areas.

Land for the disposal site should be in close proximity to the community but not so close that nuisance conditions might affect the populace. Because many small communities do not have collection systems, individuals haul their own waste to the disposal sites. Distances beyond one-half mile from the community might discourage effective disposal. Nonetheless, other factors must be weighed, such as the availability and condition of an access road, animals attracted to the waste, nuisance conditions and health factors.

A separate area in the landfill should be provided for limited resource recovery, such as the storage of noncombustible bulky objects. Additionally, a separate area should be included for dead animals and human waste. Selection of the land should be done carefully by considering soil conditions, prevailing wind direction, drainages, access and other factors. A separate resource recovery area would permit controlled salvaging, but scavenging should be discouraged and prohibited.

Open Burning. It is proposed that open burning be permitted in a modified landfill operation. This, of course, would be in violation of state and federal regulations, so permits would be necessary to allow such operations. However, under no circumstances should uncontrolled burning be permitted. Prevention of open burning will be difficult to accomplish for small operations, and a major effort should be exerted to educate landfill users of the negative factors associated with landfill burning.

Controlled burning could be accomplished by stipulations on a regulatory permit. Burning should be done infrequently and only under optimal meteorological conditions. Burning probably could be conducted on a frequency of once a month, or more often if conditions warranted. These burns should be conducted under supervision and under favorable weather conditions so nuisance conditions and safety hazards are minimized. Wind direction and velocity should be considered, and controlled burns allowed only when the prevailing wind is directed away from the community and the wind velocity is sufficient to permit good mixing and atmospheric dispersion. Burn fences (screens) should be maintained to reduce the possibility of wind-blown hot ashes and potential brush fires. Restrictions should discourage as well as prohibit the burning of rubber tires, and toxic and nuisance (pesticides, explosives, hazardous, odorous and others) materials. Tires should be separated for separate land burial or recycling.

Although controlled burns still might produce some localized air pollution and nuisance conditions, these factors could be minimized and controlled. Several positive aspects could occur from controlled open burning including reduction in volume of about 70-90%, elimination of obnoxious organic odors, sterilization of human wastes and animal carcasses, reduction of blowing litter, and so forth.

Permafrost. In many cases, permafrost soils cannot be avoided in the northern regions of Alaska. In these instances, incineration should be considered along with an economic evaluation. If incineration costs are prohibitive and no suitable land is available, it is suggested that a layer of gravel be placed on the permafrost serving as an insulation pad, and a gravel berm be constructed around the perimeter of the disposal site. This, of course, is contingent on the local availability of gravel and excavation/transportation equipment. Although solid waste has been deposited in or on permafrost for many years prior to this time (existing open dumps), virtually no research of such a process has been conducted. Little to no information is available about the effects of such an operation. It is highly recommended that immediate research be initiated to document the results of depositing solid waste in or on permafrost soils. A thaw bulb might result from such activity, so steps should be taken to confine the area of thaw as well as any leachate which might be produced. In some cases, it may be necessary to provide drains and drainage to channel snowmelt from winter accumulation away from the site. Caution must be exercised to prevent surface water contamination.

Regional Collection and Disposal. It is an obvious advantage to use regionalized collection and disposal processes where conditions permit. This approach has worked effectively in Alberta, Canada (Leskiw, 1982). However, many small communities in Alaska are not near a transportation network, and this makes the regionalized concept ineffective.

Compaction and Excavation Equipment. Small communities may not have compaction or excavation equipment available for use at solid waste disposal sites. In some cases, however, pooling of "public works" equipment might be satisfactory and economically efficient. Additionally, under special conditions state (Alaska Department of Transportation and Public Facilities) or federal (U.S.P.H.S.) equipment might be available for use.

Educational Materials. There are at least two definitive needs in the area of solid waste education. First, basic material is needed for responsible officials and supervisors explaining alternatives and methods of obtaining assistance. Second, the community residents need to be educated through meetings and printed materials about the importance of proper solid waste management and its relationship to sanitation, health, litter and safety. Although these needs seem rather simplistic, they are very important. The materials must be basic yet comprehensive and understandable by managers having little formal education. Further, they should be adapted to local conditions -- a landfill manual written for Florida is not necessarily applicable to Alaska.

Fencing. It is recommended that all landfills have some degree of fencing

around the site perimeter. This is to contain the area of dumping, restrict traffic access and discourage animals. Normally, an 8-foot, chain-link security fence would be recommended; however, in many communities this would be too expensive. For example, the cost of an 8-foot, chain-link security fence installed for a one-half-acre site could approach $10-30 per linear foot (U.S.P.H.S., 1980b) for a total cost ranging from $6,000 to $18,000. The final cost would depend on the location and type of materials used. Snow fencing might be satisfactory in certain locations.

Sewage Waste. Communities not having sewage collection systems often utilize the "honeybucket" technique. Often, the honeybucket waste is dumped indiscriminately throughout or near a community. In some cases, it is deposited at the local dump or landfill. In these instances, provisions should be made to isolate the sewage from the refuse by means of a gravel berm and to "lime" the waste or to incinerate it by controlled open burning.

Miscellaneous. Many factors necessary to the good operation of a modified landfill have not been discussed in this report. Nonetheless, these factors are important and essential components of an efficient and effective system of solid waste disposal. They include such things as supervision, site selection, drainage, signs for traffic control and hours of operation, control of salvaging, and record keeping.

Example Landfill Cost Calculation

This cost analysis is provided as a guide or estimate of the economic resources required for small communities in remote locations. Many modifications of this analysis could be necessary depending on specific conditions for the locale considered. It can be assumed that in many cases equipment will not be available for use. Where possible, consideration should be given to leasing of equipment or sharing it with other community functions (snow removal, public works, etc.). In isolated instances, it may be possible to utilize state or federal equipment.

Although trenching operations might be the preferred disposal technique, this may not be possible in certain soil conditions, such as permafrost. It is recommended that under these conditions, consideration be given to a surface-fill operation using a gravel or soil berm.

Where designs for larger communities are needed, the cost calculations used for this example may be utilized by straight-line extrapolation based on population (to approximately 500 population) for a very general cost estimate. If controlled burns are permitted in the landfill, the land required for a given design period might conservatively be reduced by as much as 50%. The cost required to close existing open dumps should also be considered as an associated part of the economics for the new landfill.

A. Given:

1. Interior Alaska village - 1982 cost base
2. Population = 100
3. Refuse generation rate = 4 pounds/person/day

4. Refuse density in the landfill = 250 pounds/cubic yard [1]
5. Landfill design life = 20 years
6. Land required

$$\frac{(4\#/cap/day)x(100\ cap)x(365\ days/yr)x(20\ yr)x(9\ ft^2/yd^2)}{(250\#/yd^3)x(10ft/3\ ft/yd)x(43{,}560\ ft^2/ac)}$$

= 0.241 acres → Use 0.3 acres

7. Assume surface fill to a depth of 10 feet [2]
8. Perimeter fencing = 450 feet [3]
9. Interest rate = 12 percent
10. Costs are conservative

B. Capital Costs:

1.	Land - 0.3 acres @ $5,000 [4]	=	$1,500
2.	Excavation equipment - purchase tracked vehicle @ $30,000 + $10,000 transportation. Assume costs allocated @ 2 hours per week (average)	=	2,000
3.	Fencing [3] - 450 feet @ $20/ft (average)	=	4,500
4.	Fill (gravel) [2] - use 6-inch pad and high berm on at least one side - estimate 800 yd^3 @ $10/$yd^3$ [5]	=	8,000
5.	Miscellaneous items - signs, road construction, gate, etc.	=	2,000
	Total Principal		$18,000

Annual cost of investment using capital recovery factor

$$A = \frac{(1+i)n(P)}{(1+i)n-1} = 2{,}274$$

C. Operating Costs:

1.	Fuel and maintenance - 2 hours/week	=	1,000
2.	Labor - 2 hours/week	=	1,500
3.	Miscellaneous	=	2,000

D. Total Capital and Operating Costs: = $6,674/year

This would amount to $67/person/year or $92/ton of disposed refuse. This abnormally high cost of disposal results from unique conditions and "economy of scale." It does, however, point out that incineration might be more favorable costwise than the literature indicates for a small Alaskan community.

These costs are considered conservative (high generation rate, high interest rate, relatively low density, quality fencing, etc.), and the calculations are presented only as an example to show the relatively very high cost of rural solid waste disposal. The costs could be lower under ideal conditions. However, it is assumed that in most instances the costs would be toward the high side due to an inability to obtain fencing at $10/foot, gravel

at $10/cubic yard and other factors. Additionally, a waste generation rate of 4 pounds per capita would result in a higher cost per ton of waste disposal but essentially the same or slightly lower per capita cost.

E. Notes:

1. If open burning is permitted, volume reduction can be achieved and land required could be reduced by half or more.

2. If a surface fill is used on permafrost, a gravel pad and berm are recommended to separate refuse from contact with soil surface. Some communities may not have gravel readily available.

3. Fencing assumes, at the minimum, isolation of the disposal area by snow fence and a higher grade fence near its access road. If open burning is permitted, a burn screen is required.

4. Due to low volume, it is recommended that when possible a community contract for or lease excavation equipment. Assuming an average use of 2 to 4 hours per week (may be a high estimate), a contract cost would be equivalent to about $30 per hour.

CHAPTER 6

SUMMARY

Solid waste disposal in small communities is hampered by many factors. Where the more advanced processes of incineration or processing are not possible due to excessive costs, it is recommended that modified landfills be operated with regulated and controlled open burns. It is essential that indiscriminate open dumping of solid waste and human sewage be stopped and replaced by controlled, supervised, and approved methods of disposal. New technologies and procedures are being developed; however, the present state of the art is primitive at best (Hassett and Conrad, 1981). Although the RCRA goals are commendable, they are not practical for small remote communities. This is not to say these goals should be ignored or abandoned, because these criteria should eventually be met.

CHAPTER 7

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CHAPTER 8

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APPENDIX A
Excerpted From
Village Sanitation in Alaska

Sponsored By:
Alaska Department of Environmental Conservation
Village Safe Water Program
United States Public Health Service
Alaska Area Native Health Service
October 15, 1977

Region	Village	Est. Population	Solid Waste Facilities
Ahtna	Cantwell	55	Haul to dump 4 miles east of town
	Chitina	25	Uncontrolled dump near Copper River
	Chistochina	35	Uncontrolled dump is 1/2 mile from village and 50' from highway/ no compacting
	Copper Center	275	Hauled by Copper Valley Construction Co. to Glennallen dump
	Gakona	25	Haul to dump 4 miles from town/open burning noted
	Gulkana	58	Uncontrolled dumping in designated area 1 mile from village/covered periodically
	Kenny Lake	125	Community landfill maintained by highway dept.
	Mentasta Lake	56	Uncontrolled dumping in pit 1 mile west of town/ dump not maintained
	Tazlina	27	Hauled by Copper Valley Construction Co. to Glennallen dump
Aleut	Akutan	74	Refuse is dumped on gravel spit/trash burned/ashes dumped into bay
	*Atka	90	Dump site near sand dunes 2 miles at old landing field/not covered/no equipment to cover/wind containment problems

*Asterisks indicate communities were not included in 1980 census. Date of information taken from "Village Sanitation in Alaska" was noted as March 1981 by Steen, UAF.

Aleut (cont)	*Belkofsky	12	Refuse is dumped and burned on beach
	*False Pass	62	DOTPF-solid waste site near/bear problems noted
	King Cove	567	Modified landfill one mile from town/collection by city/covered one time a month
	*Nelson Lagoon	62	Unfenced dumpsite along bluff at edge of town
	*Nikolski	57	Soil is very gravely/haul garbage to a point 1/2 mile west of town/too rocky for equipment/burning noted
	*Pauloff Harbor	39	Dump on beach
	*Saint George	184	Village collection system/ dump site covered sometimes
	Saint Paul	500	Collection system/dump five miles out of town/ covered every 2-3 months/ some open burning noted
	Sand Point	829	Developed dump site out of town/collection by city/some dumping of trash into sea/insufficient soil to cover
	Unalaska	725	Village uses individual plastic containers on steel stands/collected twice weekly/dumpsite two miles S.W. of town/soil conditions prohibit establishment of landfill so gravel pit will be used

Arctic Slope	Anaktuvuk Pass	150	Burn in 55 gallon drums/ uncontrolled dump site is located on east side of runway about 1 mile from village
	*Atkasook	84	Open dump 3/4 mile S. of village/village pretty clean
	Barrow	2307	Hauled to open dump/ uncontrolled/3 miles from town near NARL site/open burning noted/much indiscriminate dumping and wind containment problems (Jan 80)
	Kaktovik (Barter Island)	136	Burned in barrels/open dump at DEW line site
	Nuigsut	152	Uncontrolled dump site w/open burning
	Point Hope	408	Haul to uncontrolled dump 1/4 mile from new town site or dumped on sea ice/ gravel pits southeast of village may be used
	*Point Lay	51	200 oil drums and other debris scattered on tundra/ trash dumped on beach in summer and on ice in winter
	Wainwright	341	Collection/dump site 4 miles N.E. of village
Bering Straits	Brevig Mission	144	Dump on ice/burn at two or three sites
	*Council	35	Indiscriminant dumping behind village/uncontrolled dumpsite also used
	Diomede (Inalik)	139	Dump on ice in winter/ocean in summer
	Elim	196	Uncontrolled dump site 1/4 mile from town

Bering Straits (cont)	Gambell	376	Dump on beach in summer/ north of village/dump on ice in winter
	Golovin	118	Dump on beach and burn in summer/dump on ice in winter/landfill and trenches
	Koyuk	127	Modified landfill constructed by USPHS in 1967 as part of the total sanitation project
	Nome	2585	Municipal garbage collected and dumped in old tailings pond where it is burned/ trash also dumped on beach and burned
	Saint Michael	206	Trash dumped on ice in winter/burned on beach in summer
	Savoonga	380	Refuse dumped on shore ice ice in winter/burned on beach in summer
	Shaktoolik	160	Winter dump on ice/summer burn and fenced landfill by PHS
	Shishmaref	309	Trash dumped on ice in winter/burned on beach in summer/PHS fenced landfill/ 3/4 haul truck
	Teller	219	Dump in winter/burn in summer near beach
	Unalakleet	600	Uncontrolled dump site near Air Force site on both sides of the road/waste stored in 32 gallon drums/ carried to dump by homeowners/ covering is periodic/wind-blown trash is problem/ city has fenced part of dump

Bering Straits (cont)	Wales	134	Winter dump on ice/ summer burn on beach/ one acre fenced land-fill site near town/ no collection
	White Mountain	98	Winter dump on river ice/ burned in summer
Bristol Bay	Aleknagik (N. Shore)	227	Individual disposals/well-maintained garbage pits/ open dump accessible by boat on north shore of Aleknagik Lake/open burning noted/some trash dumped into lake
	*Chignik Bay	73	Dump site at cannery/year-round access/individuals collect and dispose of solid waste/indiscriminate dumping
	*Chignik Lagoon	30	Indiscriminate beach dumping
	*Chignik Lake	117	Fenced dump site 1/2 mile from town/no o. & m. of site/ indiscriminate dumping in village
	Clark's Point	70	Beach dumping or in pit near school
	Dillingham	1025	Open dump near airport/ truck used for collection/ open burning/visual problem/ unfenced site/dozer available for covering/site may be moved
	*Egegik	148	Indiscriminate dumping in village
	*Ekuk	3	Indiscriminate dumping on beach
	Ekwok	109	Near airport runway/indiscriminate dumping also noted in village

Bristol Bay (cont)	*Igiugig	53	Open dump near airport
	*Illiamna	102	Open dump
	*Ivanoff Bay	15	Individual garbage pits
	*Kakhonak	88	Burn/dump
	*Kanakanak and Olsonville	60	Trenches/landfill/beach dumping
	*King Salmon (excl. air base)	350	Shares landfill site with Naknek
	*Koliganek	142	Open dump
	*Levelock	95	Open dump far from town/ natural ravine is the site
	Manokotak	300	Dump 1/4 mile south of village/tractor and wagon provided by PHS/also garbage cans and racks/site covered irregularly
	*Naknek	350	Open dump is located in hillside and waste is being pushed into 2 acre land-locked pond/site shared with King Salmon
	New Stuyawk	307	Open dump west of town/ site is located in a natural depression
	Newhalen	114	Open dump 1/2 mile from village/no maintenance of site
	Nondalton	300	Dump at end of runway is used for garbage disposal
	*Pedro Bay	65	Uncontrolled dump site
	*Perryville	101	Fenced landfill site
	*Pilot Point	50	Open dump

Bristol Bay (cont)	*Portage Creek (Ohgsenakale)	66	Open dump
	Port Heiden	66	City dump/burning in dump
	*South Naknek	153	Uncontrolled open dump
	Togiak	455	Open dumps/fenced landfill being for Fall 1977
	*Twin Hills	67	Open dump
Calista	Akiak	192	Dumping in river and marshy area near village/also use privately dug ditches which are covered when full/no collection
	Akiachak	371	Two open dumps outside village
	Alakanuk	512	Indiscriminate dumping along Alakanuk River/ trash burning noted
	*Andreafsky	80	Trash burned and dumped at a few sites around village
	Aniak	375	Dumping at uncontrolled site near runway/open burning noted
	Atmautluak	140	Indiscriminate dumping in village/open burning noted
	Bethel	3700	Open dump/collection system some open burning/wind blown material/occassional flooding problem/odor problem in summer

Calista (cont)	Chefornak	236	Fenced site by airstrip/dry lakebed used as dump site near village/garbage is segregated and combustibles burned
	Chevak	550	Central disposal pit plus trash burning/promiscuous dumping on flats below village
	Chuathbaluk	117	Open dump 1/4 mile from village/much indiscriminate dumping of garbage behind houses
	*Crooked Creek (Middle)	107	USPHS landfill 1/4 mile from village near air-strip
	Eek	185	Open dump 1/4 mile South of village
	Emmonak	545	Indiscriminate dumping along Kwiguk and Yukon Rivers
	Fortuna Ledge (Marshall)	215	Open dump off the road which leads off to the site
	Goodnews Bay	248	Indiscriminate dumping in village/open dump site 1 mile from village/wagon used in summer to haul trash
	Hooper Bay	525	Bunkers - 4 or 5 families to each bunker but these are full and cannot be used/disposal is on ground/waste is burned
	*Kalskag	180	Dump/burn and cover sometimes/one half mile from village 75' X 125' pit/backhoe present plus loader
	*Kasigluk	280	Indiscriminate dumping/ burning in 55 gallon drums

Calista (cont)	*Kipnuk	579	15-20 dump sites/about 20 people use each site/garbage dumped on tundra or burned
	*Kongiganak	200	Indiscriminate dumping/garbage dumped on slough ice in winter/on river bank in summer/dump site two miles N & S of Village
	Kotlik	288	Indiscriminate dumping along river bank/trash burned in 55 gallon drums
	Kwethluk	450	Indiscriminate dumping between village and runway/ burning in 55 gallon drums noted
	*Kwigillingok	202	Indiscriminate dumping throughout village
	*Lime Village	42	Burning and indiscriminate dumping
	Mekoryuk	189	Central dumping point 250 yards out of town near ocean/ used by people extensively
	Mountain Village	513	Dump site along road cut used by village/occasionally covered by tractor/compactor
	Napakiak	293	Refuse dumped across river in shallow spot on tundra two miles from river
	Napaskiak	210	Indiscriminate dumping/burning in 55 gallon drums and waste disposed of during breakup
	Newtok	150	Indiscriminate dumping in summer/in winter, garbage is hauled out of town
	Nightmuk	123	Indiscriminate dumping along river

Calista (cont)	*Nunapitchuk	312	Fenced dump site 2 miles from village
	*Oscarville	52	Indiscriminate dumping/dump site behind school is convenient but council does not enforce or encourage dumping here
	Pilot Station	315	USPHS fenced dump site/indiscriminate dumping around village
	*Pitkas Point	84	Indiscriminate dumping along river/also dumping at site halfway to St. Marys
	Platinum	65	Uncontrolled dump near mine site
	Quinhagak	395	Old lake bed used as dump in winter/one half mile from village/in summer waste is dumped in river 1/2 mile below village
	*Red Devil	33	Open dump along river bank
	Russian Mission (Yukon)	168	USPHS dump site 300 yards from town used by community
	Saint Mary's	415	When collection truck is working, trash hauled to dump site/when broken, trash is burned
	Scammon Bay	170	Sanitary landfill located 200' from village and is used
	Sheldon Point	110	Indiscriminate dumping
	*Sleetmate	121	Indiscriminate dumping
	*Stoney River	74	30' X 10' X 6' landfill near school/plenty of fill material/ some indiscriminate dumping
	Toksook Bay	317	Uncontrolled dump site

Calista (cont)	Tununak	283	Spit on which village is located is ringed with piles of garbage/one acre site 1/2 mile from village has been fenced
	Tuluksak	258	Indiscriminate dumping
	*Tuntutuliak	223	Fenced disposal site near runway
	Upper Kalskag	160	Uncontrolled dump site between upper and lower Kalskag near runway/no maintenance
Chugach	*Chenega		Abandoned after 1964 earthquake
	*English Bay	100	Fenced 3/4 acre dump 2000' from village
	*Port Graham	197	FAA closed dump at end of runway/temporary dump at east end of village
	*Tatitlek	111	Dump site near airstrip/ no equipment to bury waste/ inaccessible in winter
Cook Inlet	*Eklutna	25	Collection system/dump covered
	*Ninilchik	134	Haul to city dump
	*Tyonek	250	Garbage is collected with flatbed truck and dumped at refuse pit 2 miles from village/refuse covered sometimes
	Seldovia	612	City collects refuse/landfill site is a ravine close to tidal zone/borough maintains landfill

Doyon	Allakaket	160	Burn and dump at a site out of town near airstrip/site located in gully/village is clean
	*Alatna	35	Indiscriminate dumping along river
	Anderson	375	Trench type landfill/ collection provided/site is covered and is one mile from town/wind containment problem
	Anvik	82	Trash burned and hauled to open dump in depression by airstrip
	*Arctic Village	101	Dump site with equipment for covering/used irregularly/garbage thrown behind houses
	*Beaver	82	Indiscriminate dumping
	*Bettles Field	57	No data
	*Birch Creek	28	Burning and dumping
	*Central	60	Dump 2 1/2 mile from town occasionally covered by DOTPF camp
	*Chalkyitsik	92	Indiscriminate dumping
	*Circle	51	Dump site near town is used
	*Dot Lake	83	Community collection system/ dump covered
	Eagle City	36	Community dump
	*Eagle Village	36	Indiscriminate dumping/ burning in 55 gallon barrels/ garbage often thrown over riverbank
	Fort Yukon	700	Dump one mile out of town/maintained and covered by city

Doyon (cont)	Galena	631	Disposal at USAF landfill on base
	Grayling	137	Dump site near airstrip's South end/covering twice a year/division of aviation uses a cat to compact trash/ no collection system/site too close to runway
	*Healy	79	Dump 1/2 mile from village is maintained by state department of transportation
	Holy Cross	285	Dump and burn at site near homes/most haul to central dump site
	Hughes	95	Haul down river in barge/ dump near end of runway one mile from village/ airport covers site
	Huslia	225	Fenced landfill outside village/access by road/ excellent solid waste control program
	Kaltag	233	Fenced dump near Yukon River built by USPHS in 1965/some routine maintenance with small state highway cats as part of highway maintenance
	Koyukuk	107	Indiscriminate dumping in village/dump site also used
	*Manley Hot Spring	77	Uncontrolled dump two miles from highway on side of hill/site is periodically covered
	McGrath	279	Village has started a collection system and landfill/borrow pit is the site about two miles from town/ bear problems at dump
	Minto	190	Two dumps outside of town/ one is near runway

Doyon (cont)	Nenana	486	-
	Nikolai	88	Dump in pit near runway
	*Northway	143	Dumping at FAA partially controlled site one mile from village/some scattered dumping noted/uncontrolled dumpsite on riverbank near village
	Nulato	330	Indiscriminate dumping along riverbank/uncontrolled community dump
	*Rampart	53	Community dump located South of airstrip is not being used/some garbage is dumped in the river
	Ruby	166	Dump site/covered sometimes
	Shageluk	169	Open dump site near town is used by most people
	*Stevens Village	56	Dump site near runway/burn in barrels
	*Tokotna	42	Dump two miles from village/site is borrow pit
	*Tanacross	90	Borrow pit adjacent to the cemetary and a wind containment problem/in winter access problem
	Tanana	447	Landfill used and covered regularly/village very clean
	*Telida	25	Trash dumped in swamps
	*Tetlin	85	Indiscriminate dumping of garbage and trash
	*Tok	709	Uncontrolled dump 4 miles from town/no maintenance/wind containment problem/open burning in summer

Doyon (cont)	*Venetie	160	PHS fenced landfill/D6 cat for covering
Koniag	Akhiok	114	Collection and dumping at designated fenced site on hillside and beach/ accessible by road/little fill material available
	*Karluk	85	Temporary landfill at new village site
	Larsen Bay	111	Good landfill site/5 acre gravelpit near airstrip/ partially fenced
	Old Harbor	330	Uncontrolled community dump site
	Ouzinkie	173	Landfill site west of town/no collection or covering/community continues to burn trash on beach
	Port Lions (Afognak moved here)	265	Landfill two miles out of town/collection weekly by city/insufficient cover for landfill/O&M may be problem for village
Nana Region	Ambler	217	Uncontrolled dump 3 miles from town/indiscriminate dumping also noted
	Buckland	174	Boat trash 1 1/2 miles downriver and dump it/ Buckland River
	Deering	104	Uncontrolled dump near runway 1 1/2 miles from village/refuse stored in drums in winter and dumped on sea ice/Bombadier collects trash
	Kiana	314	Fenced dump 1 mile/near runway

Nana Region (cont)	Kivalina	209	Indiscriminate dumping fenced site located 1 1/4 mile from village
	Kobuk	49	Uncontrolled dump 2 miles out of town/inaccessible in summer
	Kotzebue	2431	City collection/big messy dump in salt water lagoon/ site parallels runway
	*Noatak	291	Collection system/dump 1/4 mile past runway also dumped over stream embankments
	*Noatak	291	Collection system/dump 1/4 mile past runway also dumped over stream embankments
	Noorvik	531	Bi-weekly collection in summer/hauled 2 miles to fenced dump near airport
	Selawils	525	Partially controlled dump site down river
	Shungnak	181	Fenced dump site 1 mile from town near runway/ summer access to uncontrolled site is difficult/ disposal area not fenced
Sealaska	Angoon	530	Dump covered irregularly/ landfill visible from road two miles from town/ city collection system/ open burning noted
	Craig	467	Weekly pickup/two acre uncontrolled dump 300 yards from Crab Creek/not being covered/size marginal for village/serves Klawook and Craig/Craig residents pay $4.25 for pickup

Sealaska (cont)	*Elfin Cove	28 winter 100 summer	Compost for garbage/trash burned in containers, then thrown into sea
	*Gustavus	60	Modified trench landfill with burning for FAA and park service/no collection by community/department of transportation maintains landfill
	Hoonah	866	Dump sometimes covered/ planning underway for new dump as existing facility is 1/2 mile from housing complex/bears are major problem
	Hydraburg	371	Open pit with burning noted/ city collection system twice a week $15/month per residence/narrow road separates dump from old rock quarry
	Kake	679	Controlled dump five miles from town/USPHS provided truck for haul service/ during wet weather small stream flows through site/ site is covered by logging companies/12000 lbs of trash collected every two days/ $9.50 per month per residence for pickup
	Kasaan	34	PHS shallow pit 50'X50'X4' 1/4 mile from town/no collection/no cover material/ no method to transport trash to dump/burning on beach
	Klawock	250	Disposal site halfway between Klawock and Craig and is shared/some garbage dumped off bridge/disposal site is too small for future use for both communities
	*Klukwan	150	Village residents use open dump in borrow pit site

Sealaska (cont)	Kupreanof	42	Most trash is burned and buried/no dump site for village but it is clean
	*Metlakatla	1160	Large uncontrolled dump seven miles from town/ open burning/two collections a week
	*Myers Chuck	50	Dumped into ocean or on beach and burned
	Pelican	169	Open dump site on hill near town/accessible by road/covered infrequently/ open burning noted
	Port Alexander	36	Indiscriminate dumping of trash
	Saxman	300	Ketchikan collects and disposes of solid waste
	Tenakee Springs	101	Refuse is burned by individuals or dumped into water/no organized collection/ beach is free of debris
	Yakutat	500	Gravel pit used as dump site/infrequently covered/ bears are a problem at this site

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Total: 206 villages - does not include Fairbanks, Anchorage, Juneau, Homer, and others

*Not included in 1980 Census. Date of information is March 1981

Of the 206 villages included in the survey, 70 have populations less than 100, 180 have populations less than 500, 200 have populations less than 1000, and six have populations greater than 1000.

About 12 per cent of the villages have some form of solid waste collection system. Open burning is prevalent in almost 22 per cent of the communities surveyed.

Although the survey included 206 villages, it should be noted that there are many more which were not surveyed. For example, the U.S.P.H.S. lists some 374 village service units for Alaska.

APPENDIX B

RESULTS OF STATE REGULATIONS QUESTIONNAIRE

TABLE B-1. Results of Questionnaire on State Survey Solid Waste Regulations

State	1. Small Community Regulations	2. Exceptions	3. Permissible Practices	5. Inspection-Enforcement	6. Permits Required	7. Open Burning	8. Daily Cover	9. Leachate Control	10. Monitoring	11a. Operator Training	11b. Education	11c. Certification	13. State Assistance: Grants or Loans	13. State Assistance: Technical or Advisory	13. State Assistance: Equipment Loans	14. Resource Recovery	A. Transfer Stations Used	B. Small Community Regs. Being Revised	C. Written Variances In Regulations
Alabama	yes	no	cde	yes	yes	no	yes	yes	no	yes	yes	no		X		yes	X	X	X
Arizona	no	yes	cdeg	yes	yes	no	yes	no	no	yes	yes	no		X		yes	X		X
Arkansas	no	yes	cde	yes	yes	no	yes	yes	yes	yes	yes	yes		X		yes		X	X
California	no	no	bcdeg	yes	yes	no	yes	yes	yes	yes	yes	yes		X	X	yes	X		X
Colorado	no	yes	cdeg	yes	yes	no	yes	yes	no	yes	yes	no		X		no	X		
Connecticut	no	yes	cde	yes	yes	no	yes	new	yes	yes	yes	yes	X	X		yes	X		X
Delaware	no	no	cde	yes	yes	---	yes	yes	yes	no	no	no				yes			
Florida	no	yes	b	yes	yes	no	some	yes	no	no	yes	no		X		yes			
Georgia	no	no	bc	yes	yes	no	yes	yes	some	yes	yes	no	X			yes			
Hawaii	no	no	bcde	yes	yes	no	some	yes	no	yes	yes	no				yes			
Idaho	yes	---	bdeg	yes	yes	no	yes	yes	yes	no	yes	no				no	X		X
Illinois	no	no	cde	yes	yes	no	yes	yes	yes	no	yes	no						X	
Indiana	no	no	c-f	yes	yes	yes	---	yes	yes	yes	yes	no				yes	X		X
Iowa	no	no	cde	yes	yes	no	yes	yes	no	no	---	no				no	X		
Kansas	no	no	cde	yes	yes	no	yes	yes	no	yes	yes	no				no			
Kentucky	no	no	cde	yes	yes	no	yes	yes	---	yes	yes	no		X		no	X	X	
Louisiana	yes	---	c	yes	yes	no	yes	yes	yes	no	no	no		X		no			
Maine	yes	---	b	yes	yes	yes	some	some	no	no	yes	no	X	X		yes	X		X

a=open dump, b=modified landfill, c=sanitary landfill, d=incinerator w/poll. con., e=res. rec., f-conical burners, g=other

TABLE B-1. (Continued)

State	1. Small Community Regulations	2. Exceptions	3. Permissible Practices	5. Inspection-Enforcement	6. Permits Required	7. Open Burning	8. Daily Cover	9. Leachate Control	10. Monitoring	11a. Operator Training	11b. Education	11c. Certification	13. State Assistance: Grants or Loans	13. State Assistance: Technical or Advisory	13. State Assistance: Equipment Loans	14. Resource Recovery	A. Transfer Stations Used	B. Small Community Regs. Being Revised	C. Written Variances In Regulations
Maryland	no	no	bcde	yes	yes	no	yes	no	some	yes	no	no				yes			X
Massachusetts	no	yes	cde	yes	yes	no	yes	new	no	yes	yes	no		X		yes	X		X
Michigan	yes	---	cde	yes	yes	no	yes	yes	no	no	no	no		X		yes	X		X
Minnesota	yes	---	bcdeg	yes	yes	no	some	some	yes	no	no	no	X	X		yes	X		X
Mississippi	no	no	cde	yes	yes	no	some	yes	no	yes	yes	no				no			
Missouri	no	no	c	yes	yes	no	yes	yes	no	yes	---	no		X		no	X		X
Montana	yes	---	cde	yes	yes	no	yes	yes	yes	yes	yes	no	X	X		yes	X		X
Nebraska	yes	---	a-e	yes	no	yes	no	some	no	yes	yes	no		X		no	X		
Nevada	yes	---	abc	yes	no	no	yes	yes	no	no	no	no		X		---			X
New Hampshire	no	no	cde	yes	yes	no	yes	yes	yes	no	no	no				yes		X	
New Jersey	no	yes	cde	yes	yes	no	yes	new	yes	no	no	no		X		yes			X
New Mexico	yes	---	bde	yes	reg. cert.	yes	some	yes	no	yes	yes	no		X		no			X
New York	no	yes	cdeg	yes	no	yes	yes	yes	yes	yes	yes	yes		X		no	X		X
North Carolina	no	---	cde	yes	yes	no	yes	yes	yes	yes	yes	no		X		no			X
North Dakota	yes	yes	bceg	yes	yes	yes	yes	some	no	yes	yes	no		X		yes	X		X
Ohio	no	no	cde	yes	yes	no	yes	yes	yes	yes	yes	no		X		no	X		
Oklahoma	no	no	c	yes	yes	no	yes	some	some	no	no	no		X		yes			X

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TABLE B-1. (Continued)

State	1. Small Community Regulations	2. Exceptions	3. Permissible Practices	5. Inspection-Enforcement	6. Permits Required	7. Open Burning	8. Daily Cover	9. Leachate Control	10. Monitoring	11a. Operator Training	11b. Education	11c. Certification	13. State Assistance: Grants or Loans	13. State Assistance: Technical or Advisory	13. State Assistance: Equipment Loans	14. Resource Recovery	A. Transfer Stations Used	B. Small Community Regs. Being Revised	C. Written Variances In Regulations
Oregon	no	yes	b-e	yes	yes	yes	no	some	no	yes	yes	no	X	X		yes	X		X
Pennsylvania	no	no	cde	yes	yes	no	yes	yes	no	no	no	no	X			no	X		
Rhode Island	no	yes	a-e,g	yes	yes	no	yes	yes	yes	no	yes	no	X			no	X		
S. Carolina	no	no	ce	yes	yes	no	yes	yes	---	yes	yes	no		X		no	X		X
South Dakota	yes	yes	bcdeg	yes	yes	yes	yes	yes	no	yes	yes	no	X			no	X		X
Tennessee	no	no	cde	yes	yes	no	yes	yes	yes	yes	yes	no		X		yes			X
Texas	yes	---	bdg	yes	yes	yes	some	yes	no	no	yes	no		X		yes	X		X
Utah	no	no	cde	yes	*	no	yes	some	no	yes	yes	no		X		no	X		
Vermont	no	yes	cde	yes	yes	no	yes	yes	yes	no	no	no				no	X		X
Virginia	no	no	cde	yes	yes	no	yes	yes	yes	yes	yes	no		X		no	X		X
Washington	no	yes	b-g	yes	yes	no	yes	yes	no	no	yes	no	X			no			X
West Virginia	no	yes	cde	yes	yes	no	yes	yes	yes	no	no	no		X		no		X	
Wisconsin	yes	yes	b-e	yes	yes	no	yes	yes	yes	no	yes	no		X		no			X
Wyoming	yes	---	b	yes	yes	no	no	some	no	yes	yes	no				no			

* plan approval

a=open dump, b=modified landfill, c=sanitary landfill, d=incinerator w/poll. con., e=res. rec., f-conical burners, g=other